Course guides
295555 - 295EQ031 - Waste Resource Technologies

Last modified: 04/06/2021

Unit in charge: Barcelona East School of Engineering
Teaching unit: 713 - EQ - Department of Chemical Engineering.

Degree: MASTER'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2019). (Compulsory subject).

Academic year: 2021 **ECTS Credits:** 6.0 **Languages:** English

LECTURER

Coordinating lecturer: Vicenç Martí

Others: Vicenç Martí, Jose-Luis Cortina, Ignasi Casas

PRIOR SKILLS

Language of instruction is English.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CEMUEQ-06. Design, build and implement methods, processes and facilities for the integral management of supplies and residues, solid, liquid and gaseous, in industries, with the capacity to assess their impacts and risks
CEMUEQ-02. To design products, processes, systems and services of the chemical industry, as well as the optimization of others already developed, taking as a technological base the various areas of chemical engineering, including processes and transport phenomena, separation operations and engineering of chemical, nuclear, electrochemical and biochemical reactions
CEMUEQ-05. To manage and supervise all types of facilities, processes, systems and services of the different industrial areas related to chemical engineering

Generical:
CGMUEQ-02. To conceive, project, calculate and design processes, equipment, industrial facilities and services, in the field of chemical engineering and related industrial sectors, in terms of quality, safety, economy, rational and efficient use of natural resources and environment conservation
CGMUEQ-03. To lead and to manage technically and economically projects, facilities, plants, companies and technology centers in the field of chemical engineering and related industrial sectors

Transversal:
02 SCS. SUSTAINABILITY AND SOCIAL COMMITMENT. Being aware of and understanding the complexity of social and economic phenomena that characterize the welfare society. Having the ability to relate welfare to globalization and sustainability. Being able to make a balanced use of techniques, technology, the economy and sustainability.
03 TLG. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.

TEACHING METHODOLOGY

The following activities will be carried out, either in or outside the classroom, in the development of the course:

1. Lectures, participative sessions and problem solving sessions, visits (VIS)
2. Homework and assignments (HOM)
3. Project base learning (PRO)
4. Mid-term exam (MEX) and final Exam (FEX)

Detailed project information regarding the scope, content, format, deadlines, etc., will be presented in an attached document.

LEARNING OBJECTIVES OF THE SUBJECT

At the end of the course the student will be able to:

• Identify each typology of waste, its hazard and understand the kind of resources that will be obtained
• Identify and apply the proper kind of management (reduction, reusing, recycling, recovery, treatment, disposal) to optimize resources
• Preliminary design of equipment and installations for the conversion of waste in resource

STUDY LOAD

Type	Hours	Percentage
Hours small group	12,0	8.00
Hours large group	42,0	28.00
Self study	96,0	64.00

Total learning time: 150 h

CONTENTS

1-Waste concepts, scientific basis

Description:
Hazardous and non-hazardous wastes. From linear model to circular economy. Waste Framework Directive. Hierarchy of waste management (reducing, reusing, recycling, recovery, treatment, disposal). Type of wastes linked to its origin (urban, industrial, agricultural, forestal and farm wastes, construction, mining, sanitary and specific) and impact on environment. European List of Wastes. Scientific basis for waste to resource calculation.

Specific objectives:
Fundamentals of knowledge about wastes.

Full-or-part-time: 11h
Theory classes: 4h
Practical classes: 1h
Self study : 6h

2-Waste Characterization

Description:
Characterization linked to determination of resource materials, hazard classification and management of waste. Analytical methods for wastes.

Specific objectives:
Knowledge of the waste characterization for its identification, classification and its management.

Full-or-part-time: 11h
Theory classes: 3h
Practical classes: 2h
Self study : 6h

3-Reducing, reusing and recycling strategies

Description:
Initiatives for reducing, reusing and recycling. Urban waste generation and collection systems. Contaminant waste. Circular economy cycles and indicators for wastes and collection fraction.

Specific objectives:
Highlight the application of these strategies vs other following the management hierarchy.

Full-or-part-time: 13h
Theory classes: 3h
Practical classes: 2h
Self study : 8h

4-Treatment for recovery

Description:
Fundamentals of biological processes. Description and design of composting plants for biowaste. Chemical products from biowaste. Mechanical-biological treatment

Specific objectives:
To know the basis of treatment methods for the recovery of material that imply design of equipment and installations for the conversion of waste in resource

Related activities:
Visit/Seminar (VIS)

Full-or-part-time: 28h
Theory classes: 8h
Practical classes: 2h
Self study : 18h

5-Treatment of hazardous wastes

Description:
Fundamentals of mechanical separation, stripping, vapour extraction, adsorption, chemical and advanced oxidation, supercritic fluid extraction, membrane processes, stabilitation, thermal desorption, vitrification, thermic, plasma, and other techniques for the elimination of hazardous components of a waste. Air pollution control systems.

Specific objectives:
To know the basis of treatment methods for the elimination of hazardous components (design of equipment and installations)

Related activities:
Mid-term Exam (MEX) of cummulative topics 1-4.

Full-or-part-time: 25h
Theory classes: 8h
Practical classes: 2h
Self study : 15h

6-Waste to fuel and waste to energy

Description:
Biogas (anaerobic digestion plants from biowaste), pyrolysis, gasification, plasma arc. Refuse derived fuel. Description of techniques and installations of combustion/ incineration/cogeneration. Fuel cells based on wastes.

Specific objectives:
To know the basis of treatment methods for the recovery of energy and energetic products from wastes

Related activities:
Homework and Assignements (HOM)

Full-or-part-time: 23h
Theory classes: 6h
Practical classes: 2h
Self study : 15h

7-Waste Disposal

Description:
Type of landfills used for different wastes (construction, inert, non-inert, special), design of landfill. Biogas and lixiviates and its management. Incineration for the elimination of hazardous wastes. Urban mining.

Specific objectives:
Knowledge about the management of waste to landfilling and destinated to incineration to eliminate hazardous compounds.

Related activities:
Homework and Assignements (HOM)

Full-or-part-time: 13h
Theory classes: 4h
Practical classes: 1h
Self study : 8h

8-Special waste topics

Description:
Fundamentals on radiation, wastes of low, medium and high activity, nuclear power plant impact, type of storage (ATC, AGP, low activity). Reprocessing of nuclear fuel. Basis of Human Health Risk Assessment. Examples of specific management of case study wastes from the Project (PRO) activity.

Specific objectives:
To have the basis of radiactive waste management and processing as well as Human Health Riak Assessment. To know case studies of waste management based in the technologies learned in (PRO) activity.

Related activities:
Project based learning (PRO)

Full-or-part-time: 26h
Theory classes: 6h
Self study : 20h

ACTIVITIES

Visit to waste manager/attendance to seminar (VIS)

Description:
The activity will supply direct information from companies/professionals linked with the treatment of wastes to recovery. The visit/attendance to the seminar will be evaluated with a questionarie.

Full-or-part-time: 4h
Guided activities: 2h
Self study: 2h

Mid-term exam (MEX)

Description:
Mid-term exam will be an exam of the first part of the subject and capacity of the student to assimilate initial concepts.

Full-or-part-time: 50h
Guided activities: 2h
Self study: 48h

Project base learning (PRO)

Description:
The teachers will suggest a list of waste management topics to develop as a project in groups of 3-5 students. The students have to look for case studies that match with the demand and elaborate a report detailing this info and perform a presentation in the "Special topics" session to the audience

Full-or-part-time: 12h
Guided activities: 2h
Self study: 10h

Homework and assignements (HOM)

Description:
Individual activity based in solving some exercices or perform simulations using soft at home.

Full-or-part-time: 4h
Self study: 4h

GRADING SYSTEM

The final grade is determined according to the following equation:

Final grade = 0.20*MEX + 0.50*FEX + 0.1*(HOM+VIS+ PRO)

EXAMINATION RULES.

Mid-term exam and final exam performed with the use of class notes and ATENEA material.

BIBLIOGRAPHY

Basic:
- Pérez Dueñas, Lara [et al.]. Guía de caracterización de residuos peligrosos. Bilbao: Ategrus, cop. 2008. ISBN 9788461229628.
- LaGrega, Michael D; Buckingham, Phillip L; Evans, Jeffrey C. Hazardous waste management. 2n ed. Boston, MA: McGraw-Hill, cop. 2001. ISBN 0070393656.
- Christensen, Thomas H. (ed.). Solid waste technology & management. Chichester: John Wiley and Sons, 2011. ISBN 9781405175173.
- Tchobanoglous, George; Kreith, Frank. Handbook of solid waste management [on line]. 2nd ed. New York [etc.]: McGraw-Hill, cop. 2002 [Consultation: 13/05/2020]. Available on: https://sanitarac.pro/wp-content/uploads/2017/07/Solid-Waste-Management.pdf. ISBN 0071356231.

Complementary:
- Rittmann, Bruce E.; McCarty, Perry L. Environmental biotechnology : principles and applications. Boston [etc.]: McGraw-Hill, cop. 2001. ISBN 0071181849.
- Lee, C.C; Lin, Shundar (eds.). Handbook of environmental engineering calculations. 2nd ed. New York [etc.]: McGraw-Hill, cop. 2007. ISBN 9780071475839.

RESOURCES

Other resources:
Guidance documents from USEPA (https://www.epa.gov/) and other EPA.
Guidance documents from Catalan Waste Agency (http://residus.gencat.cat/en/inici/index)
Guidance documents from Ellen MCArthur Foundation (https://www.ellenmacarthurfoundation.org/)
Legislation for EC (http://ec.europa.eu/environment/waste/index.htm)
Other web-based information.